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POLE POSITION FOR 1980 BASED ON DOPPLER OBSERVATIONS OF THE GEO--ETC(U)

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The position of the earth's spin axis with respect to the crust (polar motion), was computed for the last three months of 1980 by the Defense Mapping Agency Aerospace Center on the basis of Doppler observations of the GEOS-3 satellite. The results were obtained as a contribution to Project MERIT, an international campaign to determine the best technique to replace classical astronomical procedures used to determine polar motion since 1900.

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20. (Continued)

The GEOS-3 results were found to have a somewhat higher random error than those based on Doppler observations of Navy Navigation Satellites. Significant improvement is expected with the use of an improved gravity field which is available and will be used to conduct tests of its accuracy.

FOREWORD

The International Astronomical Union and the International Association of Geodesy established the joint working group "MERIT" under the chairmanship of G. A. Wilkins of the Royal Astronomical Observatory of Greenwich, to compare various methods of the determination of the motion of the earth's pole and earth's rotation and to recommend the technique to be used in the future.

A short campaign was conducted in August and September of 1980 to evaluate logistic problems which might be encountered prior to the conduct of a two year comparison of techniques in 1983 and 1984. The techniques include Very Long Base Line Interferometric observations of pulsars, lunar laser ranging, laser observations of artificial earth satellites, Doppler observations of Navy Navigation Satellites, and classical astronomical observations. Since the GEOS-3 satellite is equipped with both a Doppler transmitter and a laser reflector, computations for that satellite provides a means of more direct comparison of the Doppler and laser techniques.

The Defense Mapping Agency Aerospace Center (DMAAC) is performing routine computations of the orbit of the GEOS-3 satellite based on Doppler observations, for the purpose of providing precise orbits for use in calibrating C-Band radars which can range to a transponder which is also aboard the spacecraft. During the short campaign and continuing to date, DMAAC computed pole position as well as orbit constants on the basis of the Doppler observations, using the same techniques employed by the Defense Mapping Agency Hydrographic/Topographic Center for Navy Navigation Satellites.

The results of these computations were provided to the Naval Surface Weapons Center by Mr. Haschal White of DMAAC and those for 1980 are compared with results from the polar satellite, in this report.

Released by:

R. T. RYLAND, JR., Head
Strategic Systems Department

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CONTENTS

INTRODUCTION

The Defense Mapping Agency Aerospace Center (DMAAC) is routinely computing the orbit of the GEOS-3 spacecraft on the basis of Doppler observations for use by other agencies in calibrating C-Band radars which range to transponders aboard the spacecraft.

Prior to August 1980, the computations were based upon pole positions computed by the Defense Mapping Agency Hydrographic/Topographic Center on the basis of Doppler observations of Navy Navigation Satellites. Starting in August 1980 and continuing to date, DMAAC introduced components of pole position as parameters of the solution along with the orbit constants. The results of these computations will provide an opportunity to compare pole positions computed from laser and Doppler observations of the same satellite, since the satellite is also equipped with laser reflectors.

This report compares the consistency of pole positions based on Doppler observations of GEOS-3 and Navy Navigation Satellites in 1980. A subsequent report will compare pole positions computed from Doppler and laser observations of GEOS-3.

PROCEDURE

The method of computation of pole position for GEOS-3 is similar to that applied to Doppler observations of Navy Navigation Satellites (Anderle, 1973). Observations are made at the sites shown in Figure 1. Since the GEOS-3 satellite radiates at the frequency pair 162/324 Mhz, observations are not available from the four operational stations for the Navy Navigation Satellite System which is equipped to make observations at the 150/400 Mhz frequencies used by that System.

As is the case for the navigation satellites, orbit computations are made for contiguous two-day spans of observations with parameters for the two components of pole position, six integration constants, and two drag scaling factors, one for each day of the two day fit, and a frequency and tropospheric refraction scaling factor for each pass of the satellite over each station. The Goddard Space Flight Center gravitational model "GEM 10" (Lerch, et al) is used in the computations since this field was found to be more accurate for use in computing orbits of the GEOS-3 satellite than the NWL 10E field used for the navigation satellites (Douglas and Anderle, 1977, reprinted in Appendix A).

A value of 398600.5 km/sec^3 is used for the earth's gravitational constant; to be consistent with this constant, station coordinates are 2.4 m lower in height than those used in computations for the navigation satellites (Anderle, 1981). The computed pole positions are given in Appendix B.

RESULTS

For purposes of comparing the internal consistency of results, the GEOS-3 and navigation satellite 1967 92A pole positions are compared with Bureau Internationale de L'Heure (BIH) Circulaire D results in Figures 2 and 3. Although the BIH include data from the navigation satellite in its results, the final results are smoothed so that the comparisons provide a measure of the internal consistency. The summary statistics are:

Satellite	Span	Mean Difference (m)		Std. Dev. (m)	
		X	Y	X	Y
NAVSAT 1967 92A	5-349	-.69	-.09	.99	0.61
NAVSAT 1970 67A	206-365	-1.05	.27	1.10	.82
GEOS-3	206-366	.18	-.13	1.89	1.47

These results include the effects of systematic deviations between positions near the end of 1980, but a comparison of the GEOS-3 and 1967 92A pole positions displayed in Figure 4 for days 206-348, gives similar results: mean differences of .86 m in X and -.04 m in Y and standard deviations of 1.87 m in X and 1.54 in Y.

Recent studies (Anderle et al, in press) indicate that effects of uncertainties in the gravity field should have a smaller effect on pole positions computed from GEOS-3 data than those computed from polar satellite data, in conflict with the results found here. A representation of the gravity field which is superior to the GEM 10 field for purposes of computing the GEOS-3 satellite orbit was obtained recently and will be tested to determine if its use will yield more self-consistent results for pole position.

SUMMARY

Processing of Doppler observations of the GEOS-3 satellite with the GEM 10 gravity field produced pole positions which are not as self-consistent as those obtained from polar satellite data. Pole positions will be computed with an improved model of the gravity field using both Doppler and laser data to determine if a higher precision can be obtained.

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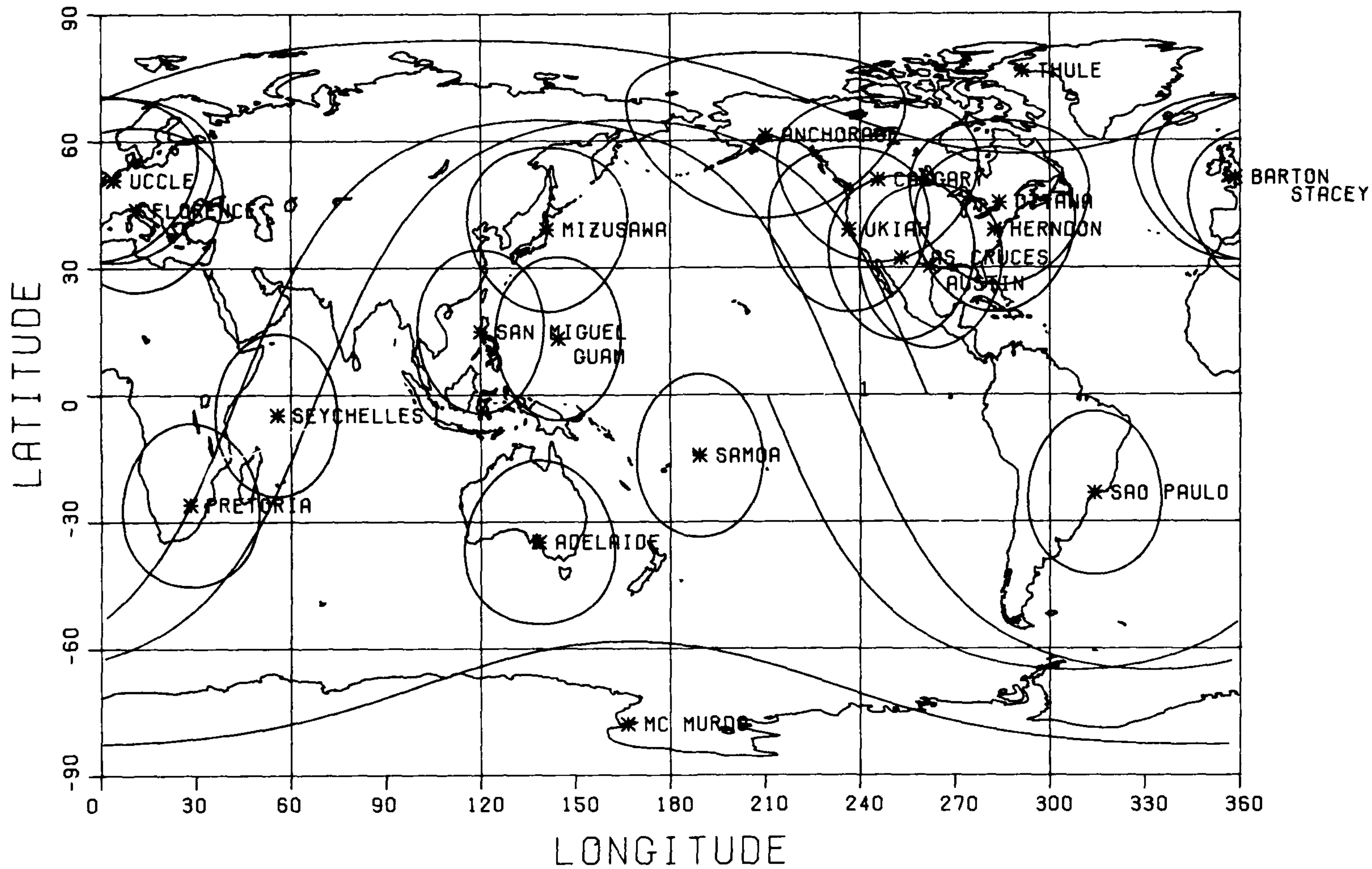

Figure 1. Doppler Station Locations

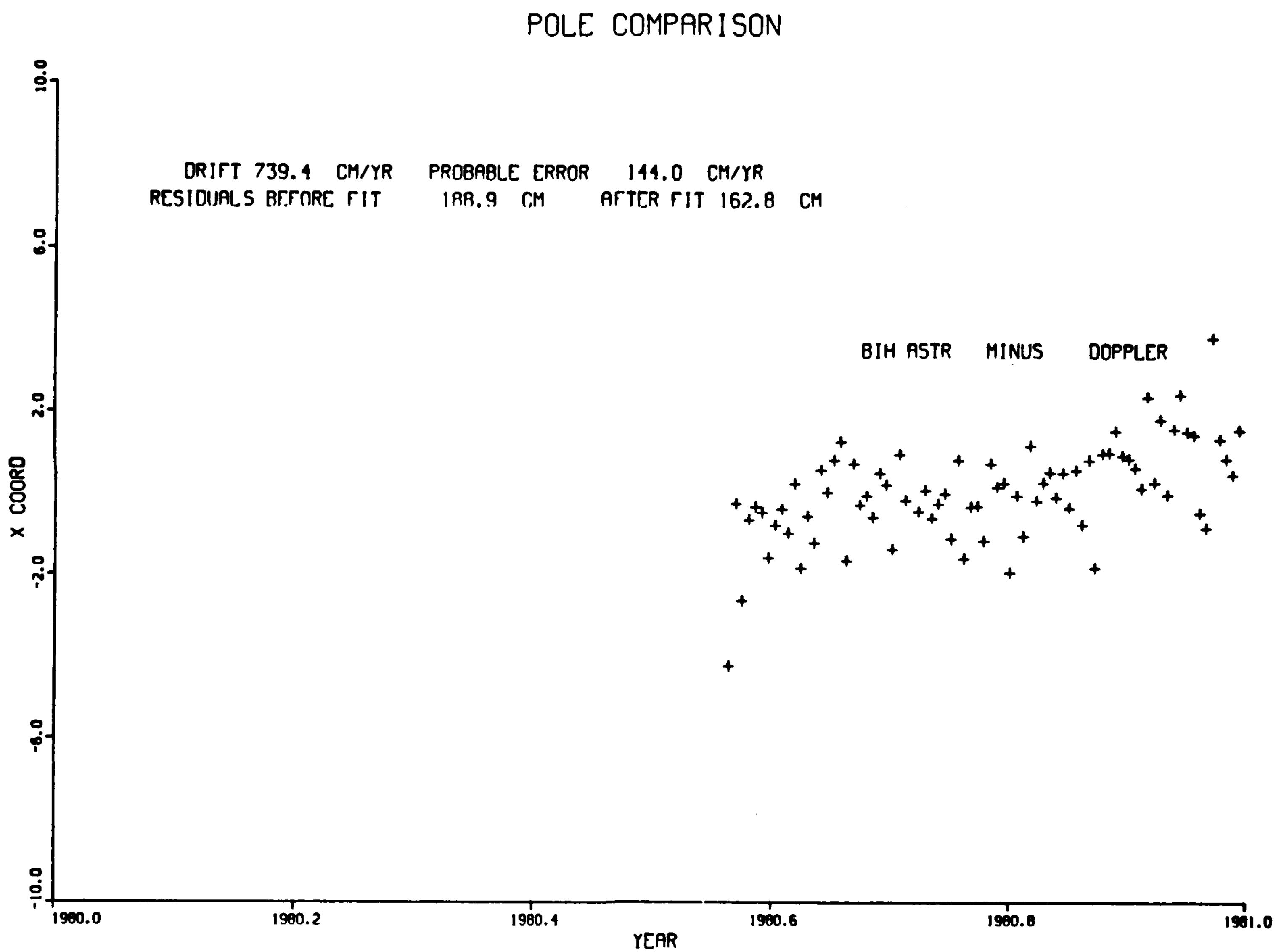

Figure 2a. Difference in X Component of Pole Position, GEOS-3 minus BIH

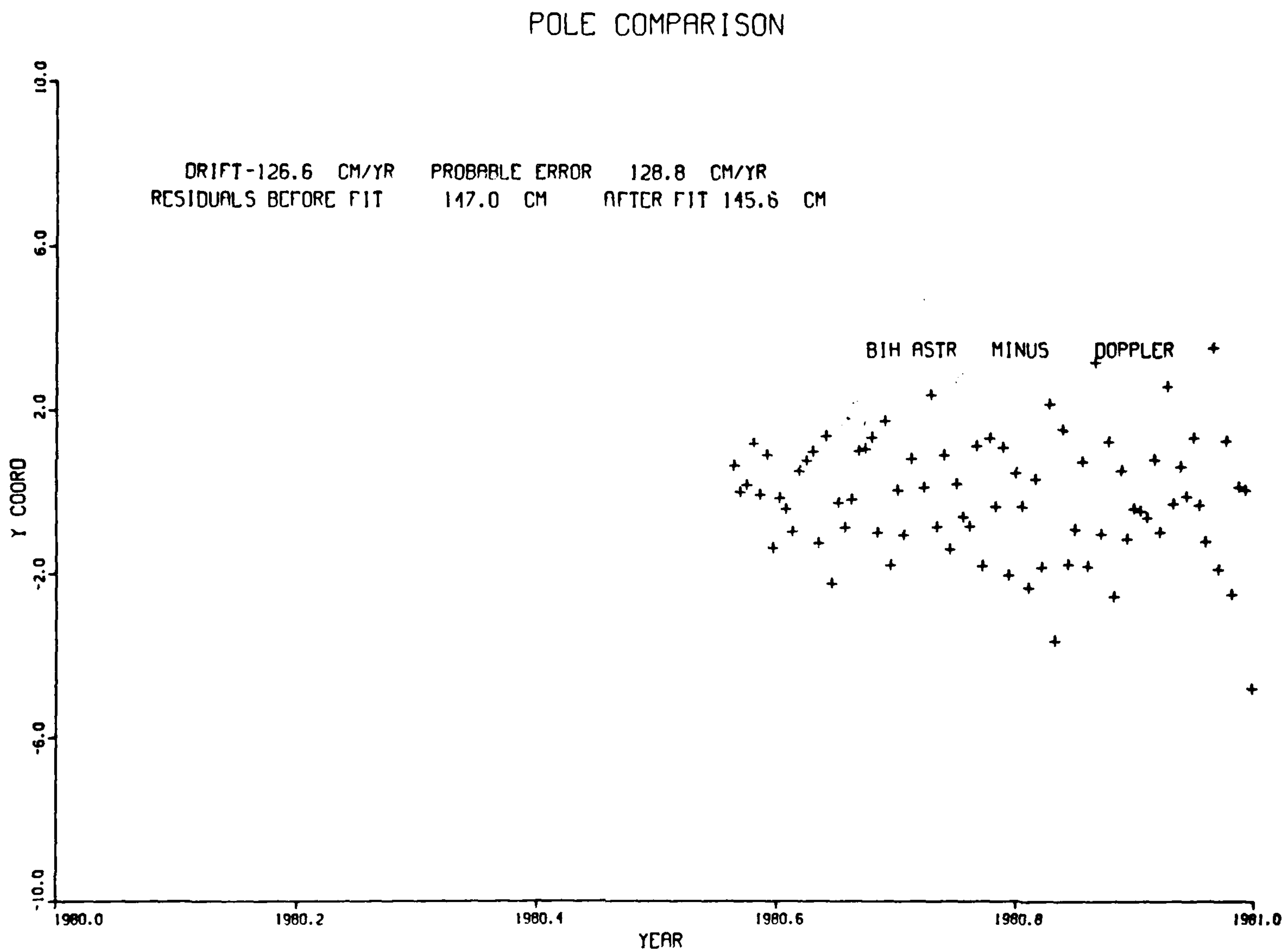

Figure 2b. Difference in Y Component of Pole Position, GEOS-3 minus BIH

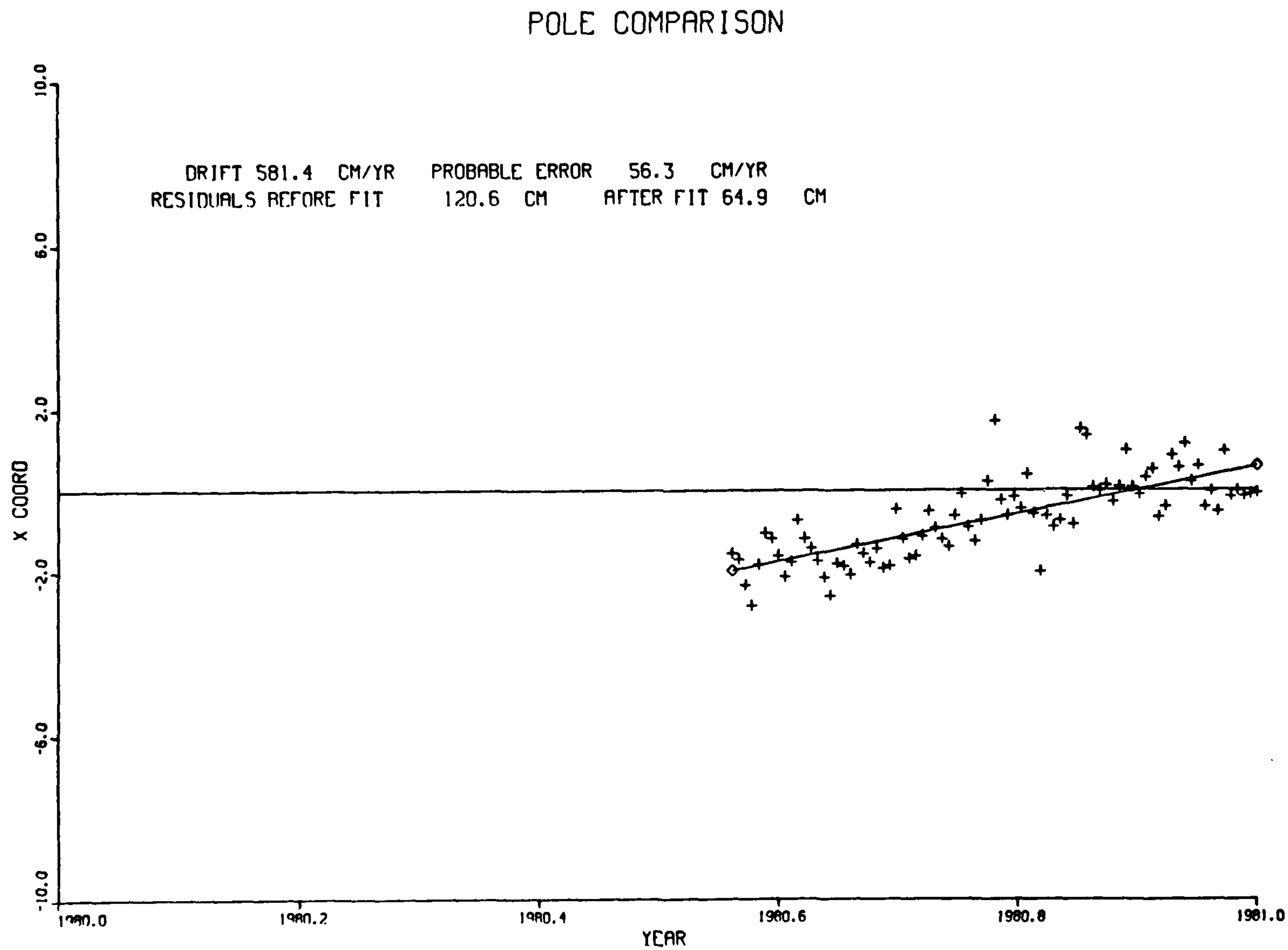

Figure 3a. Difference in X Component of Pole Position, 1967 92A minus BIH

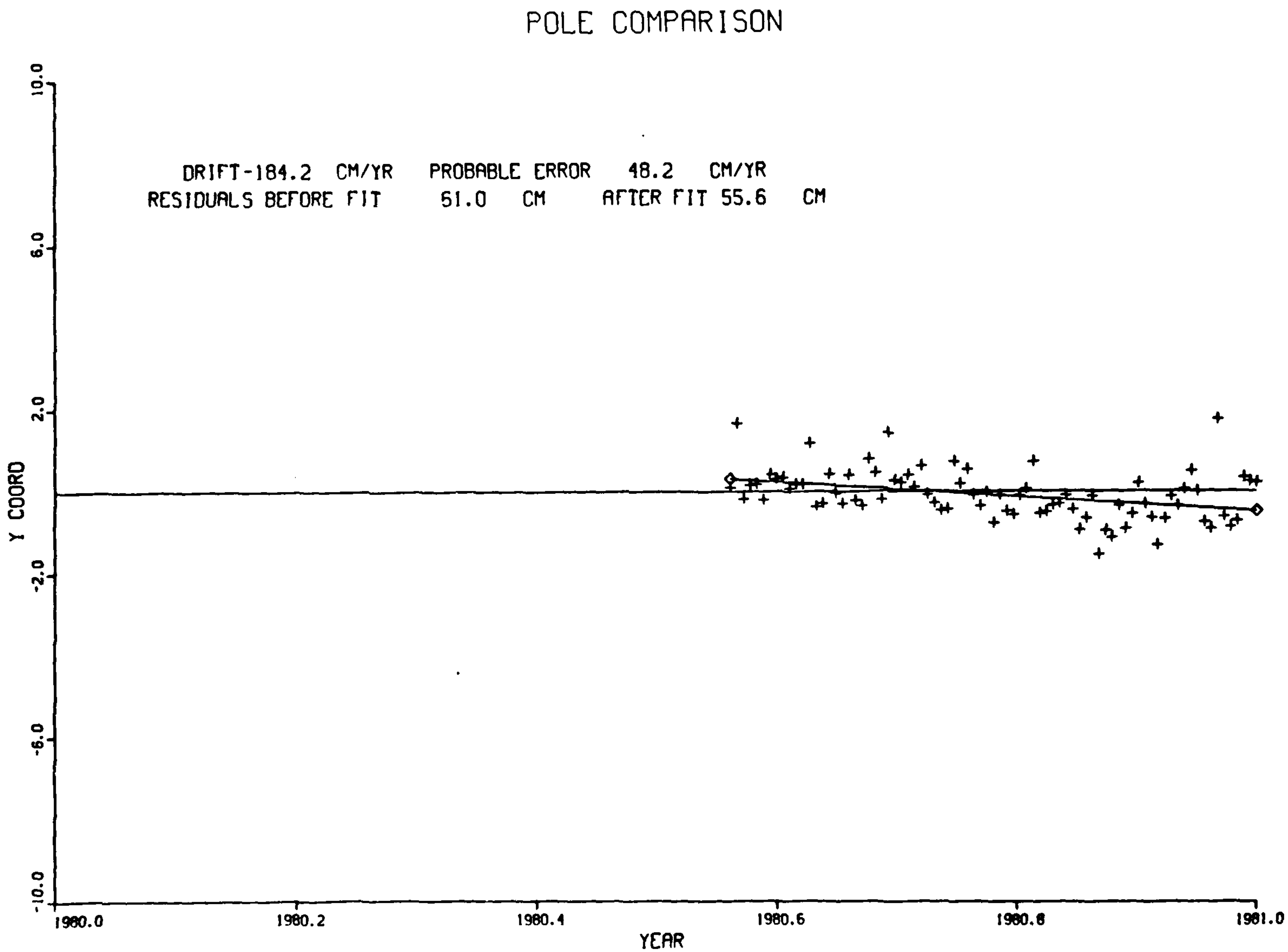

Figure 3b. Difference in Y Component of Pole Position, 1967 92A minus BIH

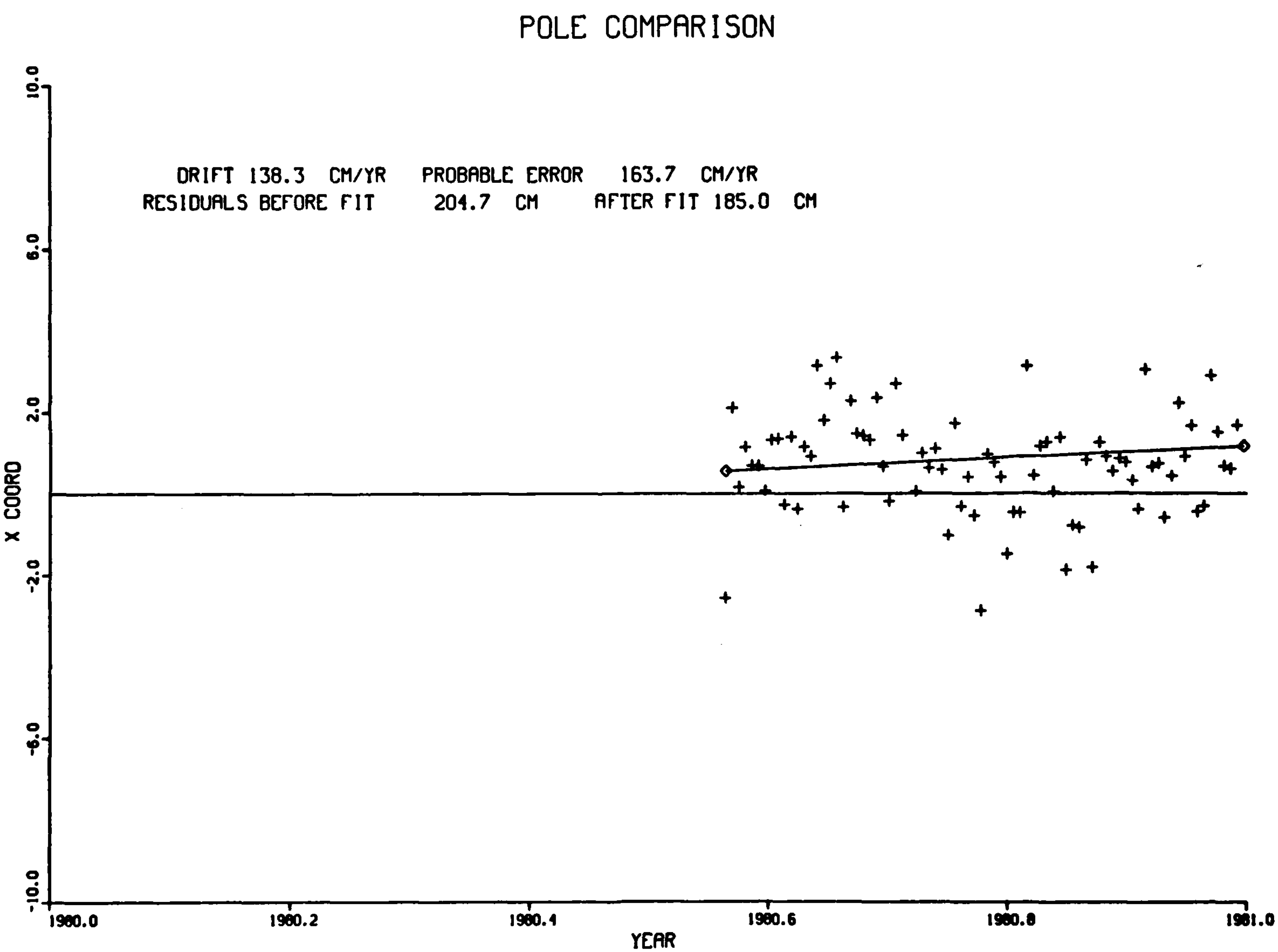

Figure 4a. Difference in X Component of Pole Position, GEOS-3 minus 1967 92A

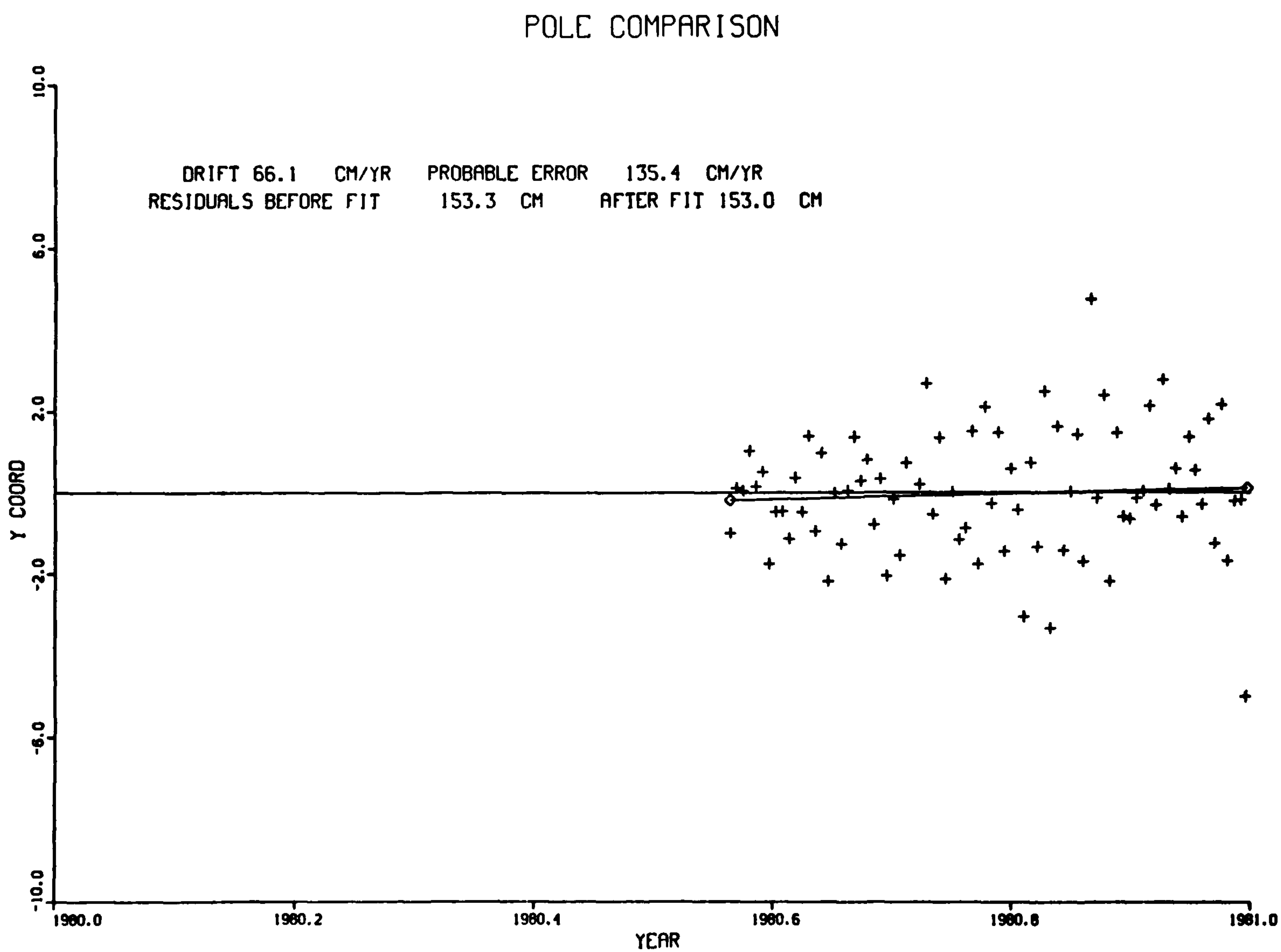

Figure 4b. Difference in Y Component of Pole Position, GEOS-3 minus 1967 92A

APPENDIX A

ACCURACY OF COMPUTED ORBITS OF GEOS-III SATELLITE

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Presented at GEOS-3 Satellite Principal Investigators Meeting, New Orleans, November 1977

ABSTRACT

Comparisons of heights of computed GEOS-III satellite orbits computed with the different gravity fields and time spans of fit suggest the following accuracies are applicable:

GEM 10 2 Day Fit: 1.5 m

NWL 1G6 3 Hour Fit: 1.5 m

NWL 1G6 2 Day Fit: 3.6 m

The comparisons show the danger of estimating the accuracy of satellite orbits by comparing orbit fits made to different time spans of data without considering the correlation of the errors in each fit due to gravity field uncertainties.

INTRODUCTION

GEOS-III satellite altimetry data has been distributed by the Wallops Flight Center with satellite ephemerides from five sources indicated as follows:

Indicator	Source	Quality
A	WFC 1 Day Arc	10 m
D	WFC 1-8 Rev Arc	3-10 m
G	NSWC 2 Day Arc	5 m
J	NSWC 2 Rev Arc	3 m
N	GSFC 5 Day Arc	1-2 m

The accuracy of the satellite orbits is poorer than the accuracy of filtered ,smoothed altimetry data, and worse than typical oceanographic effects. Therefore analysts have generally compared geoid heights computed at sub-satellite points along a given satellite track with corresponding values for satellite tracks crossing that track. Any bias in the differences in geoid heights is then interpreted as the error in the orbit of the satellite for the original track. In order to conduct this "intersection analysis" properly, the geoid height discrepancies for the crossing tracks should be weighted according to the relative accuracy of the orbit on each crossing track. The purpose of this report is to determine the weights to be assigned by evaluating the accuracy of the orbits. Only the orbits provided by the last three sources listed above are evaluated in detail.

METHODS OF ORBIT COMPUTATION

The orbit computations performed by the Goddard Space Flight Center and the Naval Surface Weapons Center differ in the types of observation used, the gravity field used and in the time span of data used in each orbit fit. The GSFC ephemerides are based on fits to five days of laser observations using the GEM 10 gravity field (Lerch et.al., 1977). The NSWC ephemerides are based on fits to either 3 hours or 48 hours of Doppler observations using the NWL 1G6 gravity field (Anderle et.al. 1975). Laser observations are more precise than Doppler data, giving range throughout each pass to 10 to 50 cm accuracy while Doppler data give range accuracy to about 50 cm accuracy at the center of the pass and range rate to about 0.3 cm/sec during the pass (Anderle, 1976). However, for GEOS-III, only five or so laser passes were obtained each day in a limited geographic region while over 100 Doppler passes were obtained from world wide stations each day. A large number of passes is important so long as the effects of gravity errors on the orbit exceed instrument errors; the gravity effects can be reduced by limiting the time span of the orbit fit provided a sufficient number of passes are acquired to determine the orbit constants. Reduction of the time span of fit to 24 hours decreases the effects on the computed orbit of errors in zonal gravity coefficients and resonant

tesseral coefficients. Further reducing the time span from 24 hours reduces the effects of errors in all other sectoral and tesseral coefficients.

TESTS OF ACCURACY OF SATELLITE ORBITS

Extensive tests of the GEM 10 and NWL 1G6 gravity fields were conducted by the originators of these fields. Considering residuals of fit, orbit comparisons for different fit spans, altimetry residuals and other tests, Lerch concluded that GEOS-III orbits computed for 5 day spans using laser data and the GEM 10 gravity field would be accurate to 1 m or better radially. Based on residuals of fit, sensitivity to gravity errors and instrument errors, Anderle concluded that GEOS-III orbits computed from for 3 hour spans using Doppler data would be accurate to 2 m radially. Subsequent comparisons of computed geoid heights computed from satellite altimetry and the respective orbits at the points of intersections of satellite sub-tracks were reasonably consistent with these estimates. Lerch (private communication) found the following agreement at intersections:

Longitude Band	No. of Intersections	RMS Difference (m)
0-100° E	14	2.1
100-250 E	44	1.4
250-360 E	54	1.5

Brace and Davenport (private communications) found just slightly higher residuals, as shown in Table 1, for a considerably larger number of test points.

COMPARISON OF SATELLITE EPHEMERIDES

Since the intersection data appeared to indicate that the 5 day GEM 10 and the 3 hour NWL 1G6 orbits are of about the same quality while the original estimates of accuracy were better than 1 m for the former and 2 m for the latter, additional tests were made. Doppler observations made on day 214 1975 were fit using GEM 10 and NWL 1G6 fields and residuals of fit and ephemerides were compared. For 48 laser fit spans, the range residuals for the GEM 10 field were 3.1 m and for the NWL 1G6 field were 5.9 while the rms of the difference in the orbit heights was 4.3 m. Short arc (3 hours) residuals and orbit comparisons given in Table 2. Both the long arc and short arc residuals indicate that the GEM 10 gravity field is better than the NWL 1G6 gravity field. The orbit differences were used to estimate the errors in each of the orbits. The unknowns in the problem are the effects of gravity errors in the GEM 10 and in the NWL 1G6 long arc orbits, the effects of instrument errors, the ratio of errors in the long to the short arcs, and the correlation of gravity errors in the long and short arc. Simulations (Anderle & Hoskin 1977) have shown that the effects of gravity errors on 3 hour fits should

be about 1/3 of those in a 24 hour. A possible increase in error between 24 hour fits and two or five day fits was neglected. The other parameters were determined by trial and error to be as follows:

correlation of gravity error:	1.0
instrument error	0.3 m (zero for long arc)
NWL 1G6 2 Day orbit error	3.6 m
GEM 10 5 Day orbit error	1.9 m

The results imply an error of 1.3 m in the NWL 1G6 3 hour orbits. The comparison of the observed differences in orbit heights with those computed with these parameters is as follows:

Comparison	Observed Differences	Computed Difference
NWL 1G6 2 Day - NWL 1G6 3 Hour	2.9 m	2.9 m
NWL 1G6 2 Day - GEM 10 3 Hour	3.6	3.7
GEM 10 2 Day - NWL 1G6 3 Hour	2.3	2.3
GEM 10 2 Day - GEM 10 3 Hour	1.5	1.6
GEM 10 2 Day - NWL 1G6 2 Day	4.3	4.1

The larger error for the GEM 10 2 day orbit with respect to the NWL 1G6 3 hour orbit is inconsistent with nearly equivalent agreement of altimetric geoid heights at the intersections of satellite subtracks when using the respective orbits. It is likely that the sample size or assumptions in the calculation is responsible for the result. A more believable estimate would be the average of the two values, or about 1 1/2 m for either orbit.

CONCLUSION

Comparisons of heights of computed GEOS-III satellite orbits computed with the different gravity fields and time spans of fit suggest the following accuracies are applicable:

GEM 10 2 Day Fit: 1.5 m

NWL 1G6 3 Hour Fit: 1.5 m

NWL 1G6 2 Day Fit: 3.6 m

The comparisons show the danger of estimating the accuracy of satellite orbits by comparing orbit fits made to different time spans of data without considering the correlation of the errors in each fit due to gravity field uncertainties.

GEOS-3 GEOID HEIGHT DIFFERENCES

AT INTERSECTIONS

OCTANT	NUMBER OF POINTS	BEFORE BIAS ADJUSTMENT		AFTER BIAS ADJUSTMENT	
		MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
NORTH ATLANTIC	1520	-0.06m	±2.02m	-.002m	±.554m
GUAM	673	-0.05m	±1.61m	-.012m	±.784m
HAWAII	609	-0.07m	±1.97m	.001m	±.563m
SOUTH ATLANTIC	655	0.17m	±2.27m	.004m	±.562m
INDIAN OCEAN	225	-0.04m	±1.46m	.022m	±.378m
AUSTRALIAN	1303	1.06m	±2.19m	-.015m	±.514m
SOUTH PACIFIC	667	0.76m	±2.23m	.012m	±.450m

TABLE 1

TABLE 2

Comparisons for GEM 10 and NWL 1G6 Gravity Fields

Day 214 1975

Fit Span[1]	Weighted Range Residuals (m) NWL 1G6	GEM 10	RMS Height Difference (m) NWL 2 Day -NWL 3 Hr	NWL 2 Day -GEM 3 HR	GEM 2 Day -NWL 3 Hr	Gem 2 Day -GEM 3 Hr
1612	2.5	3.7	---	---	2.1	1.1
1613	2.3	2.0	(5.4)	(5.3)	1.5	1.1
1614	2.0	1.4	5.5	5.5	2.1	1.2
1615	3.5	2.7	2.3	4.9	4.1	1.8
1616	2.0	2.1	1.6	3.0	2.6	2.4
1617	1.8	2.0	2.0	2.7	2.0	.6
1618	1.8	1.8	2.4	2.9	1.1	.6
1619	2.5	2.1	1.0	2.8	2.5	1.0
1620	2.1	2.7	1.7	2.7	2.5	1.2
1621	3.5	3.0	3.3	3.7	2.2	.7
1622	2.7	2.5	4.3	5.5	2.2	2.2
1623	3.6	2.3	3.3	3.6	2.9	2.3
1624[2]	2.7	2.0	2.3	3.0	2.4	1.8
1625[2]	1.9	2.3	2.7	2.9	1.4	1.1
1626	3.9	2.8	2.9	2.8	1.1	1.2
1627	4.5	3.3	2.7	2.3	1.0	.9
rms 14[2]	2.9	2.4	2.9	3.6	2.3	1.5

[1] *Fit for each orbit revolution to observations made during two orbit periods*

[2] Residuals for spans 1624 and 1625 were excluded from rms

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APPENDIX B.

POLAR MOTION RESULTS FROM GEOS-3 IN 1980

DAHLGREN POLAR MONITORING SERVICE
NWL 9 POLE BI DAILY SOLUTIONS
REPORT REVISION

	DAYS 19 8		POLE POSITION X METERS	POLE POSITION Y METERS	POSITION PRECISION X METERS	POSITION PRECISION Y METERS	SATELLITE
	206.	207.	-3.34	9.82	.210	.190	1975-27A
	208.	209.	.64	9.17	.200	.190	1975-27A
MEAN	208.		-1.25	9.49			
STD DEV	208.		2.81	.46			
STD ERR	208.		1.99	.32			
	210.	211.	-1.79	9.44	.190	.190	1975-27A
	212.	213.	.18	10.46	.200	.190	1975-27A
MEAN	212.		-.86	9.95			
STD DEV	212.		1.39	.72			
STD ERR	212.		.99	.51			
	214.	215.	.44	9.26	.210	.210	1975-27A
	216.	217.	.30	10.23	.220	.200	1975-27A
	218.	219.	-.80	7.94	.200	.190	1975-27A
MEAN	217.		-.06	9.10			
STD DEV	217.		.70	1.18			
STD ERR	217.		.40	.68			
	220.	221.	-.07	9.28	.210	.190	1975-27A
	222.	223.	.32	9.00	.230	.210	1975-27A
MEAN	222.		.11	9.15			
STD DEV	222.		.28	.19			
STD ERR	222.		.20	.13			
	224.	225.	-.32	8.53	.210	.200	1975-27A
	226.	227.	.89	10.03	.230	.200	1975-27A
	228.	229.	-1.18	10.28	.240	.200	1975-27A
MEAN	227.		-.19	9.61			
STD DEV	227.		1.00	.95			
STD ERR	227.		.58	.55			
	230.	231.	.03	10.60	.230	.190	1975-27A
	232.	233.	-.62	8.34	.230	.200	1975-27A
MEAN	232.		-.30	9.53			
STD DEV	232.		.46	1.59			
STD ERR	232.		.32	1.13			

DAHLGREN POLAR MONITORING SERVICE
NWL 9 POLE BI DAILY SOLUTIONS
REPORT REVISION

	DAYS 19 8		POLE POSITION X METERS	POLE POSITION Y METERS	POSITION PRECISION X METERS	POSITION PRECISION Y METERS	SATELLITE
	234.	235.	1.13	11.07	.210	.180	1975-27A
	236.	237.	.58	7.45	.220	.170	1975-27A
	238.	239.	1.38	9.43	.200	.170	1975-27A
MEAN	237.		1.06	9.25			
STD DEV	237.		.40	1.80			
STD ERR	237.		.23	1.04			
	240.	241.	1.80	8.88	.190	.170	1975-27A
	242.	243.	-1.12	9.57	.190	.170	1975-27A
MEAN	242.		.34	9.22			
STD DEV	242.		2.06	.49			
STD ERR	242.		1.46	.35			
	244.	245.	1.23	10.82	.200	.180	1975-27A
	246.	247.	.21	10.88	.200	.180	1975-27A
	248.	249.	.44	11.16	.180	.180	1975-27A
MEAN	247.		.61	10.95			
STD DEV	247.		.52	.18			
STD ERR	247.		.30	.11			
	250.	251.	-.15	8.91	.190	.170	1975-27A
	252.	253.	.94	11.65	.200	.170	1975-27A
MEAN	252.		.37	10.28			
STD DEV	252.		.77	1.94			
STD ERR	252.		.54	1.37			
	254.	255.	.59	8.21	.200	.180	1975-27A
	256.	257.	-.99	10.04	.200	.170	1975-27A
	258.	259.	1.34	8.94	.210	.180	1975-27A
MEAN	257.		.28	9.10			
STD DEV	257.		1.19	.93			
STD ERR	257.		.68	.54			
	260.	261.	.14	10.91	.200	.180	1975-27A

DAHLGREN POLAR MONITORING SERVICE
NWL 9 POLE BI DAILY SOLUTIONS
REPORT REVISION

	DAYS 19 8		POLE POSITION X METERS	POLE POSITION Y METERS	POSITION PRECISION X METERS	POSITION PRECISION Y METERS	SATELLITE
	264.	265.	-.19	10.29	.200	.180	1975-27A
	266.	267.	.33	12.56	.210	.190	1975-27A
	268.	269.	-.36	9.31	.200	.180	1975-27A
MEAN	267.		-.09	10.66			
STD DEV	267.		.35	1.64			
STD ERR	267.		.20	.94			
	270.	271.	-.07	11.24	.210	.170	1975-27A
	272.	273.	.18	8.92	.200	.170	1975-27A
MEAN	272.		.06	10.08			
STD DEV	272.		.17	1.64			
STD ERR	272.		.12	1.16			
	274.	275.	-.95	10.69	.180	.160	1975-27A
	276.	277.	.98	9.87	.210	.180	1975-27A
	278.	279.	-1.42	9.64	.200	.180	1975-27A
MEAN	277.		-.54	10.12			
STD DEV	277.		1.21	.57			
STD ERR	277.		.70	.33			
	280.	281.	-.20	11.75	.200	.190	1975-27A
	282.	283.	-.18	8.80	.200	.190	1975-27A
MEAN	282.		-.19	10.28			
STD DEV	282.		.01	2.08			
STD ERR	282.		.01	1.47			
	284.	285.	-1.05	12.05	.210	.190	1975-27A
	286.	287.	.84	10.37	.220	.190	1975-27A
	288.	289.	.26	11.83	.230	.190	1975-27A
MEAN	287.		-.03	11.42			
STD DEV	287.		.99	.91			
STD ERR	287.		.57	.53			
	290.	291.	.36	8.83	.210	.190	1975-27A
	292.	293.	-1.82	11.33	.220	.200	1975-27A
MEAN	292.		-.68	10.01			
STD DEV	292.		1.54	1.77			
STD ERR	292.		1.09	1.25			

DAHLGREN POLAR MONITORING SERVICE
NWL 9 POLE BI DAILY SOLUTIONS
REPORT REVISION

			POLE POSITION		POSITION PRECISION		
	DAYS	19 8	X METERS	Y METERS	X METERS	Y METERS	SATELLITE
	294.	295.	.05	10.61	.210	.190	1975-27A
	296.	297.	-.94	8.64	.200	.190	1975-27A
	298.	299.	1.27	11.31	.250	.260	1975-27A
MEAN	297.		-.03	9.98			
STD DEV	297.		1.06	1.36			
STD ERR	297.		.61	.79			
	300.	301.	-.C5	9.29	.230	.220	1975-27A
	302.	303.	.39	13.27	.210	.200	1975-27A
MEAN	302.		.19	11.47			
STD DEV	302.		.31	2.80			
STD ERR	302.		.22	1.98			
	304.	305.	.71	7.63	.210	.200	1975-27A
	306.	307.	.10	12.80	.200	.200	1975-27A
	308.	309.	.71	9.50	.210	.200	1975-27A
MEAN	307.		.49	9.98			
STD DEV	307.		.36	2.62			
STD ERR	307.		.21	1.51			
	310.	311.	-.20	10.44	.220	.200	1975-27A
	312.	313.	.74	12.12	.210	.210	1975-27A
MEAN	312.		.30	11.24			
STD DEV	312.		.66	1.19			
STD ERR	312.		.47	.84			
	314.	315.	-.66	9.64	.220	.220	1975-27A
	316.	317.	.92	14.66	.200	.200	1975-27A
	318.	319.	-1.70	10.43	.220	.210	1975-27A
MEAN	317.		-.39	11.74			
STD DEV	317.		1.35	2.75			
STD ERR	317.		.78	1.59			
	320.	321.	.96	12.77	.220	.200	1975-27A
	322.	323.	.99	8.98	.210	.190	1975-27A
MEAN	322.		.97	10.78			
STD DEV	322.		.02	2.68			
STD ERR	322.		.01	1.90			

DAHLGREN POLAR MONITORING SERVICE
NWL 9 POLE BI DAILY SOLUTIONS
REPORT REVISION

	DAYS 19 8		POLE POSITION X METERS	POLE POSITION Y METERS	POSITION PRECISION X METERS	POSITION PRECISION Y METERS	SATELLITE
	324.	325.	1.71	12.13	.210	.210	1975-27A
	326.	327.	1.11	10.44	.210	.190	1975-27A
	328.	329.	1.02	11.19	.200	.190	1975-27A
MEAN	327.		1.27	11.19			
STD DEV	327.		.37	.83			
STD ERR	327.		.21	.48			
	330.	331.	.99	11.19	.200	.180	1975-27A
	332.	333.	.49	11.02	.210	.190	1975-27A
MEAN	332.		.75	11.11			
STD DEV	332.		.36	.12			
STD ERR	332.		.25	.08			
	334.	335.	2.92	12.48	.200	.180	1975-27A
	336.	337.	.81	10.70	.230	.200	1975-27A
	338.	339.	2.36	14.28	.200	.180	1975-27A
MEAN	337.		2.14	12.61			
STD DEV	337.		1.04	1.76			
STD ERR	337.		.60	1.01			
	340.	341.	.73	11.37	.220	.190	1975-27A
	342.	343.	2.34	12.28	.200	.170	1975-27A
MEAN	342.		1.61	11.87			
STD DEV	342.		1.14	.64			
STD ERR	342.		.80	.45			
	344.	345.	3.41	11.48	.190	.220	1975-27A
	346.	347.	2.49	12.94	.210	.180	1975-27A
	348.	349.	2.41	11.27	.190	.170	1975-27A
MEAN	347.		2.79	11.92			
STD DEV	347.		.56	.94			
STD ERR	347.		.33	.54			
	350.	351.	.69	10.28	.200	.190	1975-27A
	352.	353.	.33	15.04	.210	.200	1975-27A
MEAN	352.		.51	12.54			
STD DEV	352.		.26	3.36			
STD ERR	352.		.18	2.38			

DAHLGREN POLAR MONITORING SERVICE
NWL 9 POLE BI DAILY SOLUTIONS
REPORT REVISION

	DAYS 19 8		POLE POSITION X METERS	POLE POSITION Y METERS	POSITION PRECISION X METERS	POSITION PRECISION Y METERS	SATELLITE
	354.	355.	5.17	9.52	.250	.290	1975-27A
	356.	357.	2.68	12.67	.210	.180	1975-27A
	358.	359.	2.20	8.90	.230	.210	1975-27A
MEAN	357.		3.22	10.79			
STD DEV	357.		1.51	2.19			
STD ERR	357.		.87	1.27			
	360.	361.	2.00	11.44	.190	.190	1975-27A
	362.	363.	3.09	11.36	.180	.160	1975-27A
MEAN	362.		2.58	11.39			
STD DEV	362.		.77	.06			
STD ERR	362.		.55	.04			
	364.	365.	14.70	6.39	.200	.200	1975-27A

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